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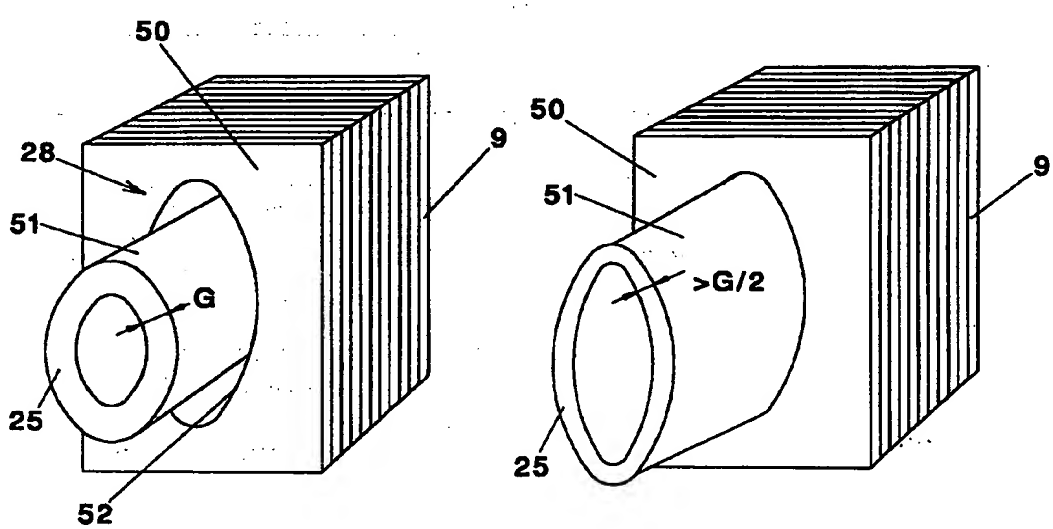

(57) Abstract

A method for mounting a cooling tube (25) in a cooling tube channel (28), the cooling tube (25) being inserted into the cooling tube channel (28), after which a pressure medium is heated and pressurizes the cooling tube (25) so that this softens and expands, its outer periphery (51) assuming the shape of the inner periphery (52) of the cooling tube channel (28), after which the hot pressure medium is replaced with or converted to a cold pressure medium which fills out the expanded cooling tube (25) and causes it to solidify and permanently assume this expanded shape, and also a rotating electric machine with cooling tubes (25) mounted in accordance with the method.

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METHOD FOR MOUNTING A COOLING TUBE IN A COOLING TUBE CHANNEL

Technical field

The present invention relates rotating electric machines such as synchronous machines. It also relates to dual-fed machines, applications in asynchronous static current converter cascades, outerpole machines and synchronous flow machines, as well as to alternating current machines intended primarily as generators in a power station for generating electric power. The invention particularly relates to the stator in such machines and a method for cooling the stator teeth and thus indirectly also the insulated electric conductor constituting the stator winding.

Background art

Similar machines have conventionally been designed for voltages in the range 15-30 kV, and 30 kV has normally been considered to be an upper limit. This generally means that a generator must be connected to the power network via a transformer which steps up the voltage to the level of the power network, which is in the range of approximately 130-400 kV. The present invention is intended primarily for use with high voltages. High voltages shall be understood here to mean voltages in excess of 10 kV. A typical operating range for the machine according to the invention may be voltages from 36 kV up to 800 kV. The invention is secondarily intended for use in the stated technical area at voltages below 36 kV.

Two different air-cooled systems exist for conventional cooling: radial cooling where the air passes the rotor through the hub and radial channels in the rotor, and axial cooling where the air is blown into the pole gaps by axial fans. The stator is divided into radial air ducts created by means of (often straight) spacers that are welded in place. Due to the poor thermal conductivity axially through the stator laminations the air ducts must be frequently repeated. The drawback with air cooling is that the ventilation losses are considerable and that, because of the ventilation ducts, the stator becomes longer. Furthermore, particularly with said high-voltage gen rators with long teeth, the ventilation ducts may also w aken the structure mechanically.

Axial liquid cooling, e.g. water cooling, by m ans of cooling tub s in the stator yoke has been known for some time. One drawback is that eddy currents are induced in metal tubes if they are present in a magnetic flux varying with time, thus leading to certain power losses when used in an electric machine.

Object of the invention

The object of the present invention is to provide a method for mounting a cooling tube in a cooling tube channel, and also a rotating electric machine comprising cooling tubes mounted using this method in conjunction with direct cooling of the stator and particularly the stator teeth in such a machine.

Another object of the invention is to eliminate ventilation ducts, thereby resulting in shorter and stronger stators, at the same time as ensuring that the magnetic flux in the stator teeth is disturbed as little as possible by said cooling. The object is also to achieve a higher degree of efficiency.

Summary of the invention

By using high-voltage insulated electric conductors with solid insulation similar to that used in cables for transmitting electric power (e.g. XLPE-cables) the voltage of the machine can be increased to such levels that it can be connected directly to the power network without an intermediate transformer. The convention transformer can thus be eliminated. The concept generally requires the slots in which the cables are placed in the stator to be deeper than with conventional technology (thicker insulation due to higher voltage and more turns in the winding). This means that the distribution of losses differs from that in a conventional machine, which in turn entails new problems in cooling the stator, for instance, and particularly the stator teeth.

The above-mentioned objects and the solution to the above-mentioned problems are achieved by the arrangement in accordance with the invention having the features defined in the appended claims.

The insulated conductor or high-voltage cable used in the present invention is flexible and is of the type described in more detail in WO 97/45919 and

WO 97/45847. The insulated conductor or cabl is described further in WO 97/45918, WO 97/45930 and WO 97/45931.

Thus, in the device in accordance with the invention the windings are preferably of a type corresponding to cables having solid, extruded insulation, like those currently used for power distribution, such as XLPE-cables or cables with EPR-insulation. Such a cable comprises an inner conductor composed of one or more strand parts, an inner semi-conducting layer surrounding the conductor, a solid insulating layer surrounding this and an outer semiconducting layer surrounding the insulating layer. Such cables are flexible, which is an important property in this context since the technology for the device according to the invention is based primarily on winding systems in which the winding is formed from conductors which are bent during assembly. The flexibility of a XLPE-cable normally corresponds to a radius of curvature of approximately 20 cm for a cable 30 mm in diameter, and a radius of curvature of approximately 65 cm for a cable 80 mm in diameter. In the present application the term "flexible" is used to indicate that the winding is flexible down to a radius of curvature in the order of four times the cable diameter, preferably eight to twelve times the cable diameter.

The winding should be constructed to retain its properties even when it is bent and when it is subjected to thermal or mechanical stress during operation. It is vital that the layers retain their adhesion to each other in this context. The material properties of the layers are decisive here, particularly their elasticity and relative coefficients of thermal expansion. In a XLPE-cable, for instance, the insulating layer consists of cross-linked, low-density polyethylene, and the semiconducting layers consist of polyethylene with soot and metal particles mixed in. Changes in volume as a result of temperature fluctuations are completely absorbed as changes in radius in the cable and, thanks to the comparatively slight difference between the coefficients of thermal expansion in the layers in relation to the elasticity of these materials, the radial expansion can take place without the adhesion between the layers being lost.

The material combinations stated above should be considered only as examples. Oth r combinations fulfilling the conditions specified and also the condition of being semiconducting, i. . having resistivity within the range of 10^{-1}-10^{6}

ohm-cm, e.g. 1-500 ohm-cm, or 10-200 ohm-cm, naturally also fall within the scope of the invention.

The insulating layer may consist, for example, of a solid thermoplastic material such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polybutylene (PB), polymethyl pentane (PMP), cross-linked materials such as cross-linked polyethylene (XLPE or PEX), or rubber such as ethylene propylene rubber (EPR) or silicon rubber.

The inner and outer semiconducting layers may be of the same basic material but with particles of conducting material such as soot or metal powder mixed in.

The mechanical properties of these materials, particularly their coefficients of thermal expansion, are affected relatively little by whether soot or metal powder is mixed in or not - at least in the proportions required to achieve the conductivity necessary according to the invention. The insulating layer and the semiconducting layers thus have substantially the same coefficients of thermal expansion.

Ethylene-vinyl-acetate copolymer/nitrile rubber, butylymp polyethylene, ethylene-acrylate-copolymers and ethylene-ethyl-acrylate copolymers may also constitute suitable polymers for the semiconducting layers.

Even when different types of material are used as base in the various layers, it is desirable for their coefficients of thermal expansion to be substantially the same. This is the case with the combination of the materials listed above.

The materials listed above have relatively good elasticity, with an E-modulus of E<500 MPa, preferably <200 MPa. The elasticity is sufficient for any minor differences between the coefficients of thermal expansion for the materials in the layers to be absorbed in the radial direction of the elasticity so that no cracks or other damage appear and so that the layers are not released from each other. The material in the layers is elastic, and the adhesion between the layers is at least of the same magnitude as in the weakest of the materials.

The conductivity of the two semiconducting layers is sufficient to substantially equalize the potential along each layer. The conductivity of the outer semiconducting layer is sufficiently large to contain the electrical field in the cable, but

at the same time sufficiently small not to give rise to significant losses due to currents induced in the longitudinal direction of the layer.

Thus, each of the two semiconducting layers essentially constitutes one equipotential surface, and the winding composed of these layers will substantially enclose the electrical field within it.

There is, of course, nothing to prevent one or more additional semiconducting layers being arranged in the insulating layer.

The present invention relates to a method for mounting a cooling tube in a cooling tube channel, the cooling tube being inserted into the cooling tube channel, after which a pressure medium is heated and pressurizes the cooling tube so that this softens and expands, its outer periphery assuming the shape of the inner periphery of the cooling tube channel, after which the hot pressure medium is replaced with or converted to a cold pressure medium which fills out the expanded cooling tube and causes it to solidify and permanently assume this expanded shape.

The invention also relates to a rotating electric machine provided with cooling tubes mounted using this method.

The machine comprises axially running cooling tubes made of a dielectric machine, e.g. a polymer, and drawn through axial cooling tube channels in the stator yoke and stator teeth. The tubes are expanded in the channels so that good heat transfer occurs when coolant is circulated in the tubes. The tubes run in the stator yoke and in the stator teeth along the entire axial length of the stator and, if necessary, they can be spliced in the stator teeth.

Polymer cooling tubes are non-conducting and the risk of short-circuiting is therefore eliminated, nor can eddy currents occur in them. Polymer cooling tubes can also be bent cold and drawn through several cooling tube channels without splicing, which is a great advantage.

Polymer cooling tubes can be produced from many materials, such as polyethylene, polypropene, polybutene, polyvinylidene fluoride, polytetrafluoroethylene, as well as filled and reinforced elastomers. Of these materials, polyethylene with high density, HDPE, is preferred since its thermal conductivity increases with increased d nsity. If the polyethylene is cross-linked, which can be

achieved by splitting a peroxide, silane cross-linking or radiation patterning, its ability to withstand pressure at increased temperature is enhanced, at the same time as the risk of voltage corrosion disappears. Cross-linked polyethylene, e.g. XLPE tubing from Wirsbo bruks AB, is used, for instance, for water pipes.

Brief description of the drawings

The invention will now be described in more detail with reference designations as in the accompanying drawings.

Figure 1 shows schematically a perspective view of a section diagonally through the stator of a rotating electric machine;

Figure 2 shows a cross section through a high-voltage cable in accordance with the present invention;

Figure 3 shows schematically a sector of a rotating electric machine;

Figure 4 shows a sector corresponding to one slot division in a stator tooth and its yoke as indicated by the broken lines in Figure 3;

Figure 5 shows an alternative sector corresponding to a slot division in a stator tooth and its yoke, with axial cooling tubes mounted in accordance with the present invention;

Figure 6 shows a cooling circuit in accordance with the present invention;

Figure 7 shows schematically a first phase of a method in accordance with the invention;

Figure 8 shows schematically a cooling tube in accordance with the invention when mounted.

Description of the invention

Figure 1 shows part of an electric machine in which the rotor has been removed to reveal more clearly how a stator 1 is arranged. The main parts of the stator 1 consist of a stator frame 2, a stator core 3 comprising stator teeth 4 and a stator yoke 5. The stator also comprises a stator winding 6 in the form of a high-voltage cable, placed in a space 7 shaped like a bicycle chain, see Figure 3, formed between each individual stator tooth 4. In Figure 3 the stator winding 6 is only indicated by its electric conductors. As shown in Figure 1, the stator winding

6 forms a coil-end bundle 8 on each side of the stator 1. Figure 3 also reveals that the insulation of the high-voltage cable is stepped in several dimensions depending on its radial location in the stator 1. For the sake of simplicity only one coil-end bundle is shown in Figure 1 at each end of the stator.

In large conventional machines the stator frame 2 often consists of a welded steel plate construction. In large machines the stator core 3, also known as the laminated core, is normally made of 0.35 mm core sheet, divided into stacks having an axial length of approximately 50 mm and separated from each other by partitions forming ventilation ducts 5 mm wide. However, in the machine described the ventilation ducts have been eliminated. In large machines each laminated stack is formed by placing sheet metal segments 9, punched to a suitable size, together to form a first layer, each subsequent layer being laid crosswise to form a complete laminated part of a stator core 3. The parts and partitions are held together by pressure brackets 10 which are pressed against pressure rings, fingers or segments, not shown. Only two pressure brackets are shown in Figure 1.

Figure 2 illustrates a cross section through a high-voltage cable 11 in accordance with the invention. The high-voltage cable 11 comprises a conductor in the form of one or more strand parts 12 made of copper (Cu), for instance, and having circular cross section. These strand parts 12 are arranged in the middle of the high-voltage cable 11. Around the strand parts 12 is a first semiconducting layer 13. Around the first semiconducting layer 13 is an insulating layer 14, e.g. XLPE insulation. Around the insulating layer 14 is a second semiconducting layer 15. The concept "high-voltage cable" in the present application thus does not comprise the outer protective sheath that normally surrounds a cable for power distribution. The high-voltage cable has a diameter within the interval 20-200 mm and a conducting area within the interval 80-3000 mm^2. In the figure showing the component forming the insulated conductor or cable, the three layers are such that they adhere to each other even when the cable is bent. The shown cable is flexible and this property is retained throughout the service life of the cable.

Figure 3 shows schematically a radial sector of a machine with a sheet metal segment 9 of the stator 1 and a rotor pole 16 on the rotor 17 of the machine.

It is also clear that the high-voltage cable 11 is arranged in the space 7 resembling a bicycle chain, formed between each stator tooth 4.

Figure 4 shows a tooth sector 18 corresponding to a slot division as indicated by the dotted radial lines in Figure 3, also known, as slot division sector, defining the tooth height as the radial distance from the point 19 of the tooth to the outer end 20 of the space 7 resembling a bicycle chain. The length of a stator tooth is thus equivalent to the tooth height. The yoke height is also defined as the radial distance from the end 20 of the space 7 resembling a bicycle chain to the outer edge 21 of the stator core 3. This latter distance denotes the breadth of an outer yoke part 22. Furthermore, a tooth waist 23 is defined as being one of several narrow parts formed along each stator tooth by the space 7 resembling a bicycle chain, between the stator teeth. A number of tooth maxima 24 are thus formed radially between each tooth waist 23, the dimensions of which increase from a smallest maximum nearest the point 19 of the tooth to a largest maximum nearest the end 20 of the space 7 resembling a bicycle chain. As is clear from the figure, the width of the outer yoke part increases outwardly towards the outer edge 21 of the stator core 3 in the sector shown.

In a high-voltage rotating electric machine of the type described above, in accordance with the invention at least one stator tooth 4, see Figure 5, is provided with at least one substantially axially running cooling tube 25, connected to a cooling circuit in which coolant is arranged to circulate. The cooling tubes are either circular or elliptical. In a possible embodiment the cooling tubes may be arranged using oil as coolant. Cooling tubes are preferably arranged in every stator tooth in order to achieve efficient cooling. It is also clear from the embodiment of the invention shown in Figure 5 that four single cooling tubes are arranged to run axially through the actual tooth, while another two cooling tubes are arranged to run axially through the outer yoke part 22 of the sector illustrated. As revealed in the figure, two narrower cooling tubes may be arranged next to each other in at least one tooth maximum, instead of one thicker tube. Each of these tubes then belongs to its own parallel cooling circuit. The advantage is that narrower cooling tubes ar asi r to bend to a smaller radius. Another advantage with narrow tubes is that they do not block the magnetic flux direction to the same extent as a thick

tube. This advantage is also achieved with elliptical tubes located with the large axis in the radial direction of the tooth. According to one mbodiment all tooth maxima are provided with double cooling tubes. All cooling tubes in the same slot division sector are also arranged radially in line with each other. Cooling also takes place on the earth potential. Other embodiments with cooling tubes arranged in conjunction with the stator winding 6 also lie within the scope of the appended claims, such as cooling tubes placed between the windings in a triangular space 26, e.g. as attachment elements to the windings, or in specially arranged slots in a tooth side 27.

Each cooling tube 25 is manufactured from a dielectric material such as a polymer, preferably XLPE, in order to avoid electrical contact with the laminations in the stator tooth 4 or the outer yoke part 22.

Each cooling tube is mounted axially in a cooling tube channel 28 running in the stator 1.

All cooling tubes 25 are connected to a closed cooling circuit 29, see Figure 6, which in the embodiment shown comprises a tank 30 containing coolant 31 for the circuit. The coolant may be water, hydrogen gas or some other medium. The tank 30 is provided with a level indicator for controlling and monitoring the coolant level. The tank 30 is also connected to two annular conduits consisting of an inlet loop 32 and an outlet loop 33. A number of parallel circuits, often corresponding to the number of stator teeth or tooth sides provided with cooling tubes, are connected between the inlet loop 32 and outlet loop 33, on such parallel circuit 34 being shown in Figure 6. The coolant 31 is thus arranged to circulate from the inlet loop 32 simultaneously through each parallel circuit 34 to the outlet loop 33, to a circulation pump 35 and to a circulation filter 36, through a heat exchanger 37, e.g. a flat heat exchanger, and then back to the inlet loop 32. Water is fed by an exchange pump 38 through one end of the heat exchanger 37, from a water catchment via an exchange filter, not shown. The water is pumped through the exchanger and back to the water catchment.

When manufacturing a stator cooled in accordance with the present invention, the first cooling circuit 29 is dimensioned taking into consideration possible distances between th cooling tubes 25. The distances between the tubes

must be chosen so that they can be placed centrally in the wid st parts, at a tooth maximum 24 of the stator tooth 4. This is important from the magnetic aspect, so as to avoid magnetic saturation in the stator teeth. A thermal calculation is performed so that the correct number of tubes is obtained, with radial and axial distances between them, ensuring a uniform distribution of temperature in the high-voltage cables. The cooling tube channels are inserted in the punching templates for the stator laminations and no additional work phase is thus required. The cooling tubes 25 are inserted after the stator laminations have been laid but before the stator is wound.

Figures 7 and 8 illustrate the method in accordance with the invention whereby a cooling tube 25 with wall thickness G is inserted into a cooling tube channel 28 in a stator part, shown schematically, with its punched segment 9. The cooling tube 25 is inserted in the cooling tube channel 28, after which a pressure medium is heated and pressurizes the cooling tube 25 so that this softens and expands, the outer periphery of the cooling tube thus assuming the shape of the inner periphery 52 of the cooling tube channel 28, see Figure 8, after which the hot pressure medium is replaced, under constant pressure, with a cold pressure medium that fills out the expanded cooling tube 25 and causes this to solidify and permanently assume this expanded shape. It is possible to use the same pressure medium, but at different temperatures. The hot pressure medium has a temperature above the softening temperature of the cooling tube, whereas the cold medium has a temperature below the softening temperature. To prevent the free parts of the pressure tube, i.e. the parts situated outside the stator, from expanding freely, these parts are provided with expansion protection before the cooling tube is initially pressurized.

When the cooling tube 25 expands, its wall thickness G decreases. The cooling tube 25 is permitted to expand until 50% remains of its original wall thickness G. The wall thickness and diameter of the cooling tube are selected so that the remaining wall thickness is sufficient after the tube has expanded to completely fill out all space between the outer periphery 51 of the cooling tube and the inner periphery 52 of the cooling tube channel 28.

The material in the cooling tube is selected taking into consideration factors such as coefficient of thermal conductivity, coefficient of expansion and possibility of thermoforming.

CLAIMS

1. A method for mounting a cooling tube (25) in a cooling tube channel (28), **characterized** in that the cooling tube (25) is inserted into the cooling tube channel (28), after which a pressure medium is heated and pressurizes the cooling tube (25) so that this softens and expands, its outer periphery (51) assuming the shape of the inner periphery (52) of the cooling tube channel (28), after which the hot pressure medium is replaced with or converted to a cold pressure medium which fills out the expanded cooling tube (25) and causes it to solidify and permanently assume this expanded shape.

2. A method as claimed in claim 1, **characterized** in that the cooling tube is mounted in a stator (1) with high-voltage cable (11), for a rotating electric machine.

3. A method as claimed in any of claims 1-2, **characterized** in that the cooling tube (25) is allowed to expanded until 50% remains of its original wall thickness (G).

4. A rotating electric machine with cooling tubes (25) mounted as claimed in any of claims 2-3, **characterized** in that the stator (1) is provided with stator teeth (4) extending radially inwards from an outer yoke part (22), and is provided with at least one cooling tube (25) made of dielectric material and inserted in a cooling tube channel (28) running substantially axially through the stator (1), said cooling tube being connected to a cooling circuit (29) in which coolant (31) is arranged to circulate.

5. A machine as claimed in claim 4, **characterized** in that the cooling tube (25) is made of polymer material.

6. A machine as claimed in claim 4, **characterized** in that the cooling tube (25) is made of high-density polyethylene (HDPE).

7. A machine as claimed in claim 4, **characterized** in that the cooling tube (25) is made of cross-linked polyethylene (XLPE).

8. A machine as claimed in any of claims 4-7, **characterized** in that the cooling tube (25) is arranged inside at least one stator tooth (4).

9. A machine as claimed in claim 8, **characterized** in that each stator tooth (4) is provided with at least one axially running cooling tube (25) connected to a cooling circuit (29) in which coolant (31) is arranged to circulate.

10. A machine as claimed in any of claims 8-9, **characterized** in that each tooth sector (18) is provided with at least four axially running cooling tubes (25), whereof at least three cooling tubes (25) are arranged to run in the stator tooth (4) and the remaining cooling tube(s) (25) is/are arranged to run in the outer yoke part (22).

11. A machine as claimed in any of claims 8-10, **characterized** in that the cooling tubes (25) situated in the stator tooth (4) are arranged centrally in a tooth maximum (24) in the stator tooth (4).

12. A machine as claimed in any of claims 8-11, **characterized** in that all cooling tubes (25) belonging to one and the same tooth sector (18) are oriented radially in line with each other.

13. A machine as claimed in any of claims 11-12, **characterized** in that at least one tooth maximum is provided with two cooling tubes (25).

14. A machine as claimed in any of claims 4-13, **characterized** in that the cooling tubes (25) have an elliptical cross section.

15. A machine as claimed in any of claims 4-14, **characterized** in that the high-voltage cable (11) comprises an inner conductor composed of one or more strand parts (12) around which is arranged a first semiconducting layer (13), around which is arranged an insulating layer (14), around which is arranged a second semiconducting layer (15).

16. A machine as claimed in claim 15, **characterized** in that the layers (13, 14, 15) are arranged to adhere to each other even when the insulated conductor or cable is bent.

17. A machine as claimed in any of claims 4-16, **characterized** in that the high-voltage cable (11) has a diameter within the interval 20-200 mm and a conducting area within the interval 80-3000 mm^2.

Fig. 1

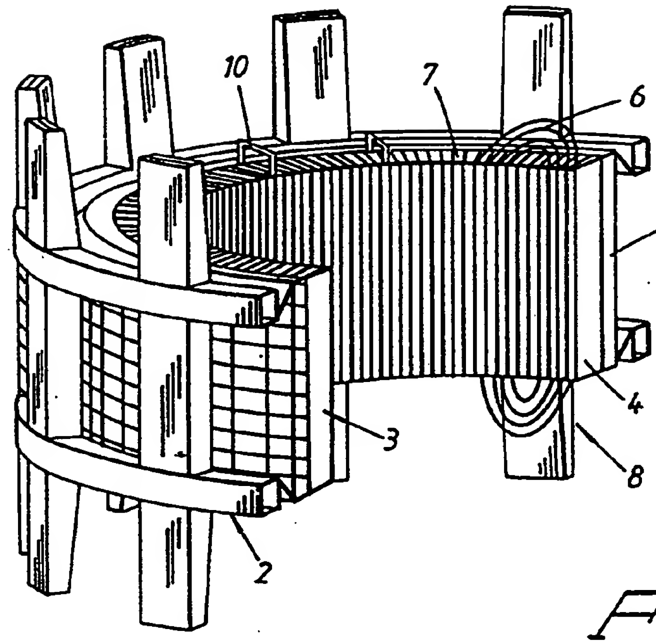

Fig. 3

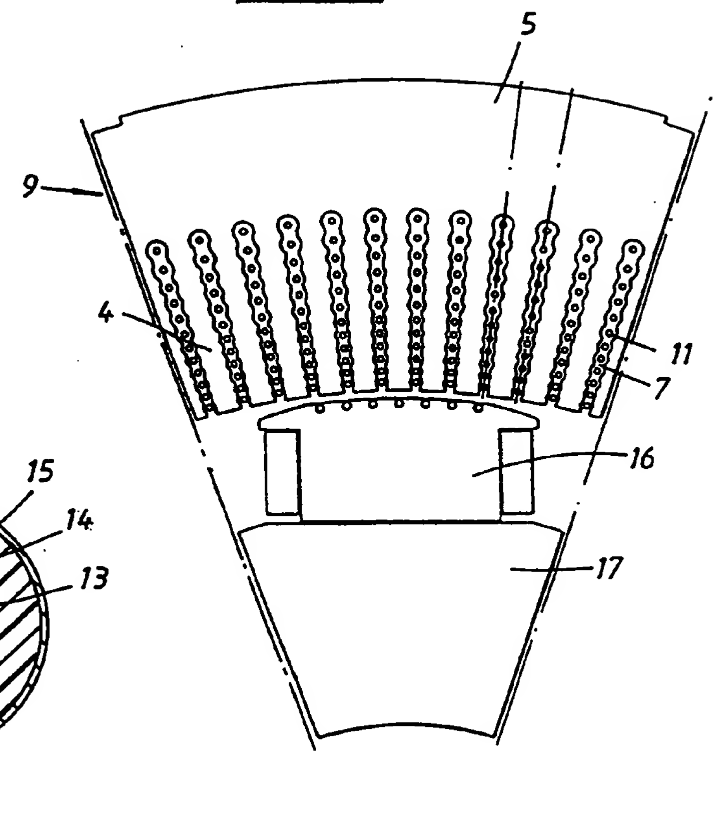

Fig. 2

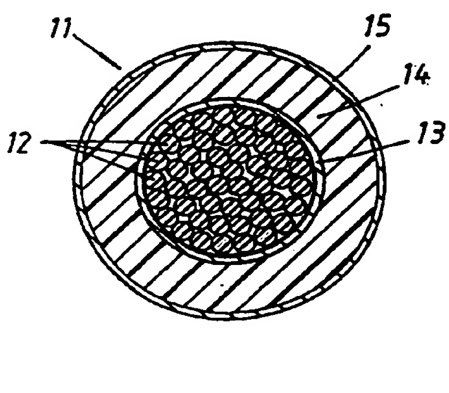

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Fig. 4

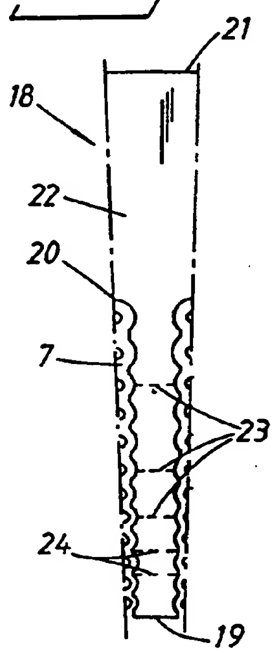


Fig. 5

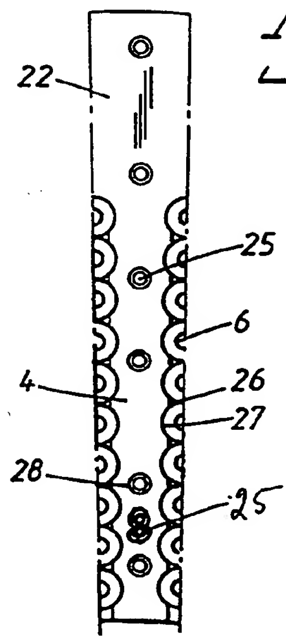
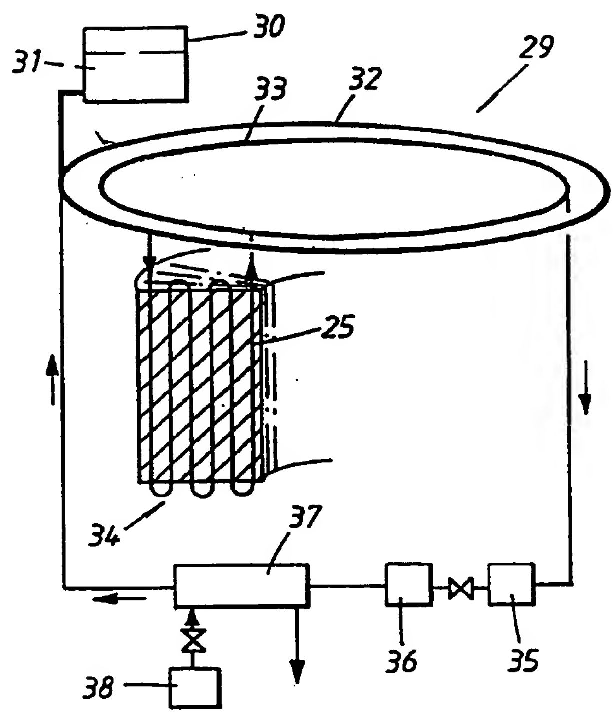


Fig. 6



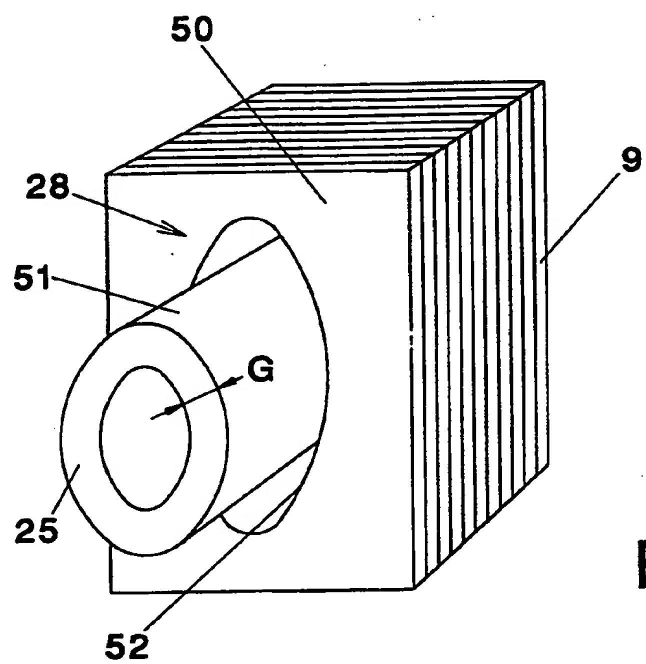


Fig 7

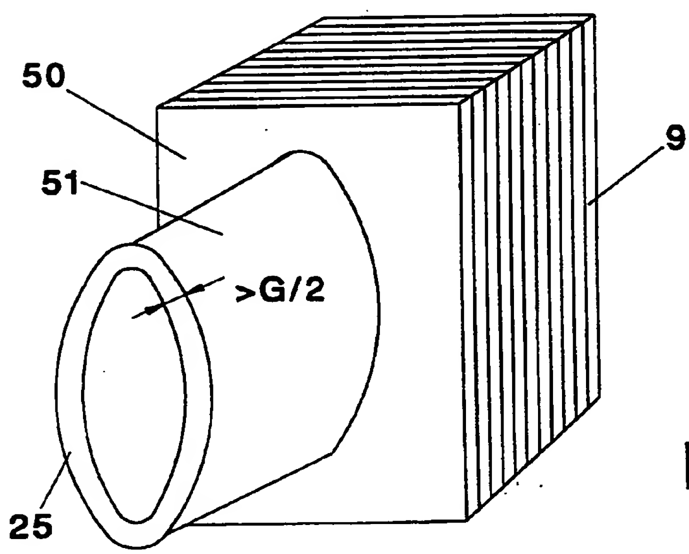


Fig 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01743

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02K 1/20, F16L 55/162

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5587126 A (C.STEKETEE,JR), 24 December 1996 (24.12.96), column 13, line 49 - column 14, line 44, figures 8,29, abstract --	1
A	US 4785138 A (OTTO BREITENBACH ET AL), 15 November 1988 (15.11.88), see the whole document --	15,16
A	EP 0342554 A1 (MAGNET-MOTOR GESELLSCHAFT FüR MAGNETMOTORISCHE TECHNIK MBH), 23 November 1989 (23.11.89), see the whole document --	1-17

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" erlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 December 1998	15 -12- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Karin Säfsten Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01743

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5397513 A (C.STEKETEE,JR.), 14 March 1995 (14.03.95), figures 3,4, abstract --	1
A	US 5036165 A (R.ELTON ET AL), 30 July 1991 (30.07.91), abstract -- --------	15,16

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Information on patent family members

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